XXIX. *Experiments on the Formation of Colonies by* Lasius fuliginosus ♀♀. By Horace St. J. K. Donisthorpe, F.Z.S., and W. C. Crawley, B.A.

[Read November 15th, 1911.]

In a paper read at the meeting of the Entomological Society of London on December 7th, 1910, Donisthorpe stated that it was our intention to carry out experiments with queens of *Lasius fuliginosus* and observation nests of *L. umbratus*. This we have now done, and the following paper shows the results of our investigations. Our object was to find out if small *umbratus* colonies would accept *fuliginosus* ♀♀ as their queens. We may state at once that in this we have been quite successful. It may, however, perhaps be as well to recapitulate the facts that led us to make this inquiry, before giving the details of our experiments.

In 1908 de Lanoy published the fact that he had found in 1904 at Knoche-sur-Mèr in Belgium, a large colony of *Lasius fuliginosus* in which workers of *L. mixtus* (a subspecies of *umbratus*) were present, and that subsequently in 1906 he had found several other colonies of *fuliginosus* containing *mixtus* workers.

Forel and Emery then expressed the opinion that the meaning of the presence of these strange workers was that a fertile ♀ *fuliginosus* had entered a nest of *mixtus* to found her colony; that she had been accepted by the workers of the latter, and that the *mixtus* ♀ had either died or been killed. In the course of time, the *fuliginosus* brood being reared, the *mixtus* workers had died off, and the few found in the nest were the last survivals of the original *mixtus* colony.

In 1909 Wasmann accepted this interpretation, and pointed out that subterranean nests of *mixtus* and *umbratus* are frequently found at the foot of trees close to the nests of *fuliginosus*, and that he had often seen workers of these yellow *Lasius* among the black *fuliginosus*. He urged those naturalists who have the opportunity to make experiments with these ants.

In 1910 Crawley records that in 1898 he frequently saw workers which must have been *umbratus* in a large colony of *fuliginosus*, and that they sometimes saluted each other when they met. Donisthorpe records that in 1897 he found a large colony of *fuliginosus* in a hollow tree at Lymington, and that *umbratus* was living with it, both species coming in and going out together.

Wheeler, when describing an ant from Japan, which he considered might be the β female of *fuliginosus*, refers to the above records, and states that they clearly indicate that this method of colony foundation is actually adopted by *fuliginosus* queens in a manner analogous to that employed by the North American and European *Formicae* of the *rufa*, *exsecta* and *microgyna* groups when they enter nests of *F. fusca* and *incerta*.

In 1911 Donisthorpe points out that *fuliginosus* often founds new colonies by branch nests as in the *rufa* group, which accounts for the fact that in a district where *fuliginosus* occurs, so many colonies are often to be found. He states that the ♀ is unable to found her own colony, and that she enters a nest of *umbratus*, and is accepted by them. He also mentions that on September 20th, 1900, Mr. Tuck of Bury St. Edmunds sent him a worker of *umbratus* taken in a nest of *fuliginosus* in an old horse-chestnut stump in that neighbourhood.

In Switzerland, in May 1905, Crawley observed workers from a colony of *fuliginosus* dragging deälated females back into their nest after the marriage flight. He took a dozen of these ♀♀, and isolated some and put others with ☿☿ from their own nest; but none made any attempt to excavate cells or found colonies in any way, and in a few weeks all had died.

On July 1st, 1910, we dug up a bagful of refuse from a large nest of *L. fuliginosus* in a hollow oak at Darenth Wood. It contained a number of ☿☿, larvae, and a large number of ♂♂ and winged ♀♀. This nest was divided into two portions, each containing an approximately equal number of ♂♂ and ♀♀. During July most of the winged ♀♀, and all the ♂♂, died or were killed by the ☿☿, but about a dozen ♀♀ were found with their wings removed. As some of these ♀♀ subsequently laid a large quantity of eggs, it is highly probable that they had been fertilised in the nest by their brothers. Individuals selected from these deälated ♀♀ were used in our experiments.

On December 8th, 1910, we visited a nest of *umbratus* at Weybridge, which was in the ground under the old root of a tree. This contained a number of ☿☿ and a lot of winged ♀♀, but we were unable to find a deälated queen. It was unfortunate, as it would have been very interesting to prove if the *umbratus* ♀ was killed either by the *fuliginosus* ♀, or her own ☿☿. However, we intend to carry out further experiments when the *umbratus* ♀ is present in a nest.

We took about 400 ☿☿ and 30 winged ♀♀, which we divided into two lots, and established them in two separate "Crawley" plaster nests.

Experiment No. 1.

On December 10th, 1910, a deälated *fuliginosus* ♀ was introduced into the first chamber of *umbratus* nest No. 1. The *umbratus* ☿☿ had already killed and cut up five of their own winged ♀ ♀. The *fuliginosus* ♀ endeavoured to join the *umbratus* ☿☿ at once, forcing her way into the most crowded chamber. One ☿ saluted her, another dragged her by the jaws through the passage into another chamber (☿☿ always drag their own ♀ by the jaws, not by the legs or antennae, when they wish her to move into another place). Eventually she was attacked by many ☿☿, held by the legs and antennae, and was dead in the evening. As will be seen, she was not attacked at once or in the same way as is a strange ant in another nest. For instance, one of the *umbratus* ♀♀ was introduced into the *fuliginosus* nest. She was instantly set upon and killed in a few minutes.

Experiment No. 2.

On December 13th a deälated *fuliginosus* ♀ was put into a small single-chamber plaster nest with a dozen *umbratus* ☿☿ taken from "Crawley" nest No. 1. She was threatened by the ☿☿ with their jaws, and a little attacked. She never tried to run away, but always approached the ☿☿ and endeavoured to conciliate them. She stood still when attacked by a ☿, and stroked and caressed it with her antennae. When a ☿ endeavoured to bite at her waist she protected it by crossing her hind legs over her back, and when at the neck by pressing the head back close against the thorax. By December 20th, the ☿☿ having been increased to 22, and all seeming to be

reconciled to the ♀, she was introduced with them into nest No. 1. A fresh ☿ or two which had not seen her before threatened her with its jaws, and she was a little attacked, but one of the old ☿☿ protected her, getting between her and the others, and pulling them away by the leg.

On December 21st the ♀ was surrounded by a number of ☿☿.

On December 22nd she was observed to be fed by some of the ☿☿ whilst others cleaned her.

On December 23rd one ☿ threatened her with its jaws, and was often pushed away by the others. Another ☿ held her by the leg for some time.

On December 24th another of the *umbratus* winged ♀ was killed by the ☿☿. It may be mentioned that when the *umbratus* winged ♀♀ met the *fuliginosus* ♀ they opened their jaws at her, but did not attack her. When they meet each other they salute in a rather ridiculous manner.

On December 30th the *fuliginosus* ♀ was quite accepted. She was always surrounded by a large group of *umbratus* ☿☿, fed by them, and continually cleaned. She stroked all those near her with her antennae, and seemed perfectly happy and contented.

On March 15th, 1911, we exhibited the two *umbratus* nests at the meeting of the Entomological Society of London, to show that both colonies had accepted *fuliginosus* ♀♀ as their queens.

All went well till April, when a number of the *umbratus* ☿☿ began to die off in nest No. 1. On April 20th a further visit was made to Weybridge, and a large number of ☿☿ were brought home from the old nest, and some 400 were introduced into this nest. The new ☿☿ were quite friendly with the old ones, but unfortunately they attacked the *fuliginosus* ♀. She was removed and isolated with 24 of the new ☿☿. They refused to accept her, and on April 17th she was still being attacked; it was impossible to get her reinstated in the *umbratus* nest.

On April 21st she was returned to her own *fuliginosus* nest. The ☿☿ were much excited, and she was much pulled about. She was eventually lost sight of among the crowds of ants. It is, however, clear that if so many new ☿☿ had not been introduced together into the *umbratus* nest, the *fuliginosus* ♀ would have laid her eggs and brought up her brood in this nest.

On July 13th a number of eggs had been laid in the *fuliginosus* nest, and on the 23rd a ♀ with her abdomen enormously dilated was noticed in the damp chamber of the nest, with a large pile of eggs surrounded by ☿☿.

It may be as well to record that a winged *fuliginosus* ♀, introduced into the *fuliginosus* nest, from Oxshott on June 1st, was at once killed by the ☿☿.

Experiment No. 3.

On December 10th, 1910, at 1.25 p.m., a single *umbratus* ☿ from the Weybridge colony was placed in a glass-topped box with a fertile *fuliginosus* ♀. The ☿ crept up behind the ♀, touched her abdomen with its antennae, then drew back. The ☿ again advanced with open mandibles several times, but did not actually attack the ♀, who remained perfectly quiet. 1.32 p.m. another ☿ was put in, which behaved in a similar manner to the first. One of the ☿☿ examined the ♀, but neither saluted her, though she seemed quite friendly. 1.39 p.m. a third ☿ was put in. 1.41 p.m. by way of contrast a winged *umbratus* ♀ from the same colony was put with them. The ☿☿ saluted her, and the *fuliginosus* ♀ behaved to her just as she had behaved to the ☿☿. Then a ☿ got on the *fuliginosus* ♀'s back and bit savagely at her: she shook off the ☿ and ran away. At 1.50 p.m. the *umbratus* ♀ was removed, and the *fuliginosus* left alone with the three *umbratus* ☿☿. 1.52 p.m. another ☿ was observed to bite at the ♀, who again ran off.

Next morning the four ants were found close together in the box, apparently quite friendly; so at 11.45 a.m. the three ☿☿ were restored to their nest (No. 2 *umbratus* nest), and the *fuliginosus* ♀ put in after them. Ants came up to her with threatening jaws, but did not actually bite her. Later, however, one or two got hold of her legs, but, except in two cases, did not hold on for long. Once an ant saluted her: this may have been one of the three that had been confined with her since the previous day. At 12.30 p.m. a *flavus* ♀ (fertile) was introduced into the nest for comparison. To our surprise she was not at once attacked, but soon a ☿ fixed on her antennae, and held on so persistently that the ♀ was removed. Between 1.9 p.m. and 8 p.m. the *fuliginosus* ♀ was observed to be attacked four times. Whenever she was held by a leg it was interesting to see how patiently she stroked the

assailant with her antennae, which method of conciliation was generally successful. When attacked on the thorax or abdomen she endeavoured to push off the ant with her hind pair of legs.

December 12th, at 9.40 a.m. she was held by an antenna and a leg, but seemed uninjured. Again at 3.30, 3.33, 4.40 and 11.46 p.m. she was attacked and held by legs and antennae, and once a ☿ was seen to pull at the leg of another ☿ who was attacking the ♀. She was so severely attacked that it was considered advisable to remove her with four ☿☿ to a small box for the night. At 7.40 p.m. on December 13th, not having been attacked again, she was restored with the ☿☿ to the nest, and found her way to the innermost chamber where there were most ants. She was observed to be held by ☿☿ on three occasions during the evening. Next day she was observed to caress a winged *umbratus* ♀ with her antennae and tongue at 12.15 p.m. At 7.15 p.m. she was surrounded by ☿☿, one of whom pulled at one of her legs, but another was licking her, and a third saluted her. She caressed the assailant with her antennae and forelegs. Later in the evening other ants were seen to salute her. December 15th, she was attacked three times during the day, but there were generally several ants round her caressing her.

On the 16th she was only attacked once, and the next day she was seen to be on the wall of one of the chambers with a circle of ants round her, behaving as they do to their own queen. There was no sign of any attacking at all.

The whole of the next day, December 18th, she spent in this position, and seemed thoroughly at home. She remained in the same place on the side of the chamber for a whole week. It was curious to compare the calmness with which this ♀ was received by the somewhat phlegmatic *umbratus*, with the excitement with which a colony of *Lasius niger* receives an *umbratus* queen.

On March 22nd, 1911, the ☿☿ in the colony of *fuliginosus* from which the above-mentioned queen had been taken, having nearly all died, a second *fuliginosus* queen was taken and put into the *umbratus* nest at 10.30 p.m. She found her way into one of the inner chambers, but drew back nervously from the first ants she met. They, however, were so friendly that she lost her fear and went among them. Only one or two opened their mandibles

on meeting her, and most saluted her at once. It was a complete and almost instantaneous acceptance. At 10.40 p.m. a *fuliginosus* ☿ was put into the nest. She remained absolutely quiet till 10.56, all the time surrounded by *umbratus* ☿☿. They then began to attack her, and she was removed at 11.10 p.m. A fertile *umbratus* ♀ from a different colony, put in the nest at 10.45 p.m., was not attacked till 10.56, when she was seized by several ☿☿, and so was removed at 11.10 p.m. A *niger* ♀ was introduced at 11.1 p.m., and was almost immediately attacked. At 11.40 p.m. the second *fuliginosus* ♀ found her way to the innermost chamber, and began to caress the original ♀, who was, of course, her sister, and they generally remained together afterwards. The colony now consisted of 157 *umbratus* ☿☿ and two *fuliginosus* ♀♀.

During April 1911, two more *fuliginosus* queens were put into the nest, and were received just as readily as the second. They both belonged to the same colony that the first two had come from. On May 9th one of these two new ♀♀ (which had been in a feeble condition from the first) died. On the 11th, at 8.45 p.m., several *umbratus* ☿☿ from a colony at Wellington College were put into the nest, which, it will be remembered, consisted of ants from a colony at Weybridge. These ☿☿ were received in a perfectly friendly way, so about fifty more were put in, and were also received. At 10.15 p.m. two of the new-comers were attacking one of the three *fuliginosus* ♀♀, and again at 10.25 and 10.40 p.m. It was necessary to compel them to release the ♀. No further attacks were seen that day or the next, so twenty more ☿☿ were put in. One almost immediately began to attack a ♀, and on two other occasions during the day the ♀♀ were attacked. At 4.40 p.m. on May 12th, as the new-comers seemed to have become reconciled to the presence of the alien ♀♀, the remainder of the *umbratus* ☿☿, about thirty in number, were introduced. At 5.6 one ♀ was being pulled by a leg, and at 5.40 another was held by an antenna, but no more attacks were made. Workers from a colony at Woking were also received amicably. On May 19th one of the ♀♀ was removed and placed in the nest of a queenless colony of her own species, *L. fuliginosus*. She was attacked continuously in a desultory fashion, but made no attempts to conciliate her assailants by caresses. Next day she was still being dragged about, so at 2.5 p.m. she was restored

to the *umbratus* nest. Here she was at once attacked by five ants, so was removed and placed in a separate chamber with three *umbratus* to allow her to get rid of the *fuliginosus* odour, but she was still attacked by one of the three. As she was again attacked the following day on being restored to the nest, no further attempt was made to induce the colony to take her back.

In time the abdomens of the two ♀♀ began to become distended, and on the 17th there was a batch of about twenty eggs. These eggs were added to from day to day, and the queens' bodies became enormously distended so that they appeared like semi-transparent whitish sacs, with narrow bands of black.

On August 9th the eggs began to hatch, and the larvae grew rapidly in size and numbers. At the moment of writing (November 13th, 1911) there is a large number of half-grown larvae, which should, all being well, pupate early next spring.

Several times during the past summer *L. niger* pupae have been given to this colony, to try and ascertain whether the *umbratus* ☿☿ had any friendly instincts remaining towards the species in a colony of which they, in all probability, began their existence. The pupae were always readily carried in, but seemed to be left too long before being opened, with the result that the ☿☿ were dead or crippled when they did emerge. However, several lived for some time, but seemed to be bullied by the *umbratus*. There are now two *niger* ☿☿ in the nest, apparently in a perfectly healthy condition, and unmolested by their hosts.

It would have been more satisfactory in some ways if this paper had been delayed until the larvae had pupated and hatched. But as we have now proved for the first time the hypothesis that *L. fuliginosus* ♀♀ can be accepted by colonies of *L. umbratus* and bring up their young with the aid of their hosts, it seemed of greater importance to put the facts on record at once.

Crawley has already demonstrated (1909) that queens of *L. umbratus* (the other British parasitic species of this genus) do not lay eggs until the year following impregnation. We have now shown that is also the case with *L. fuliginosus*, as the ♀♀ fertilised in July 1910 did not lay till June and July 1911.

The queens of both these species are smaller in com-

parison with their ☿☿ than the queens of the rest of the genus, and have large heads and small bodies. It is clear that ♀♀ with delayed fertility and such a small store of body fat could not possibly exist without assistance during the two years that must elapse between their impregnation and the appearance of the first ☿☿ from their eggs. In short, this proves that queens of this species are unable to found colonies by themselves.

Appended is a list of all the literature on the subject known to us.

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(4) "Workers of Lasius flavus (*L. umbratus*) among *Lasius fuliginosus*." Ent. Record, xxii, 1910, pp. 67–99.

Donisthorpe, H. St. J. K.—(2) "Myrmecophilous Coleoptera in 1897." Ent. Record, 1897, p. 246.

(42) "On the Founding of Nests of Ants." Ent. Record, 1910, p. 8.

(45) "Temporary Social Parasitism and Slavery in Ants." Trans. Ent. Soc. Lond., 1911, Pt. I, pp. 180–181.

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